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DEPARTMENT OF THE ARMY **LRL-13080L (June 2001)**
U.S. ARMY CORPS OF ENGINEERS ----------

UNIFIED FACILITIES GUIDE SPCIFICATIONS

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13080

SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT

06/01

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DEPARTMENT OF THE ARMY **LRL-13080L (June 2001)**
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UNIFIED FACILITIES GUIDE SPCIFICATIONS

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SECTION 13080

SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT

06/01

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NOTE: This guide specification covers the requirements for seismic protective elements for protection of mechanical and electrical equipment, building piping, conduit, and exterior utilities. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

****

PART 1 GENERAL

****

NOTE: The intent of this specification is to provide for adequate lateral support against earthquake induced motions for mechanical and electrical equipment and systems described herein. A vertical support system is also required as called for in other Sections of these specifications.

The design of structural members, whether prepared by an A-E or in house, will be checked for adequacy. The designs and detail drawings submitted by the Contractor will be checked against the accepted design; drawings of structural connections will require Government approval. The Government designer has final responsibility for the adequacy of the structural members and their connections.

This section can be used for bracing details of medical equipment by editing the specification accordingly.

****

1.1 REFERENCES

****

NOTE: Issue (date) of references included in

project specifications need not be more current than provided by the latest change to this guide specification.

The listed references should not be manually edited except to add new references. References not used in the text will be deleted from this paragraph during the SpecsIntact reference reconciliation process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.70	(1981) Earthquake Actuated Automatic Gas Shutoff Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1994a) Carbon Structural Steel
ASTM A 53	(1995a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 153	(1996) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A 500	(1993) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563	(1994) Carbon and Alloy Steel Nuts
ASTM A 603	(1988) Zinc-Coated Steel Structural Wire Rope
ASTM A 653	(1995) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM E 488	(1990) Strength of Anchors in Concrete and Masonry Elements
ASTM E 580	(1991) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Seismic Restraint

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(1981; Supple 1991; R 1992) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

ICBO-099S94	(1994) Uniform Building Code

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION(SMACNA)

SMACNA-12	(1991; Appx E, 1993) Seismic Restraint Manual Guidelines for Mechanical Systems

UNDERWRITERS LABORATORIES (UL)

UL 1570	(1995) Fluorescent Lighting Fixtures
UL 1571	(1995) Incandescent Lighting Fixtures

1.2 SYSTEM DESCRIPTION

1.2.1 General

****

NOTE: Seismic zone in which project is located must be inserted in the blank space; seismic zone and importance factor will be obtained from TM 5-809-10. The building category (I, II, III, or IV), which is based on the building occupancy and is used in determining the importance factor, will be obtained from TM 5-809-10. This section will not be used in Zone 0.

Designer should verify that specified details do not interfere with the performance of the cathodic protection system (when used) or of the vibration isolation systems.

****

The requirements for seismic protection measures described in this section shall be applied to mechanical/electrical equipment and systems specified herein. Seismic protection requirements shall be in accordance with ICBO-099S94 using an importance factor of [_____] and shall be provided in addition to any other requirements called for in other sections of these specifications. This facility shall be designed as being in seismic zone [_____]; no other zone values shall be used to establish bracing requirements. Lateral support against earthquake induced forces shall be accomplished by positive attachments without consideration of friction resulting from gravity loads.

1.2.2 Mechanical/Electrical Equipment

****

NOTE: The designer should ensure that the list below includes all electrical and mechanical items to be braced. Delete the items which are not part of the job and add items which are not included in the list.

****

Mechanical/electrical equipment shall include the following items to the extent required on the drawings or in other sections of these specifications:

Boilers and furnaces	Storage Tanks for Oil and Water
Water Heaters	Steam, Water, Oil and Gas Piping
Expansion Air Separator Tanks	Cable Trays
Heat Exchangers	Bridge Cranes and Monorails
Water Chiller Units	Engine-Driven Generators
Cooling Towers	Air and Refrigerant Compressors
Control Panels	Air Handling Units
Pumps with Motors	Switchgear
Light Fixtures	Unit Substations
Motor Control Centers	Transformers
Switchboards (Floor Mounted)	Storage Racks
Suspended Ceiling Assemblies	Ducts
Flash Tanks	Unit Heaters
Accumulator Tank	Exhaust and Return Fans
[_____]	Solar Heating Units

1.2.3 Mechanical/Electrical Systems

****

NOTE: The designer should ensure that the list below includes all piping and mechanical/electrical systems which are to be installed or modified. Delete the systems which are not part of the job and add systems which are not included in the list.

****

The following mechanical and electrical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:

All Piping Inside the Building in Accordance With This Specification

Chilled Water Distribution Systems Outside of Buildings

Gas Distribution Systems

Oil Piping Outside of Buildings

All Water Supply Systems

Storm and Sanitary Sewer Systems

All Process Piping

Outside Heat Distribution, Return, and Condensate Systems

Condenser Water Piping Outside the Building

Pneumatic Tube Distribution System

[_____]

1.2.4 Equipment and Systems

****

NOTE: Retain this paragraph when the Contractor will design the bracing. The designer will refer and/or modify the listings above or will list below the equipment and systems to receive seismic bracing. Delete this paragraph when all bracing details and locations are indicated on the drawings.

****

The bracing for the following mechanical/electrical equipment and systems shall be developed by the Contractor in accordance with the requirements of this specification: [_____].

1.2.5 Exclusion

Seismic protection of piping for fire protection systems shall be installed as specified in Sections 15330 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION, 15331 DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION, and 15332 PREACTION AND DELUGE SPRINKLER SYSTEMS, FIRE PROTECTION.

1.2.6 Pipes and Ducts Requiring No Special Seismic Restraints

****

NOTE: Retain only those items found in the project for this list of pipes and ducts that do not require seismic restraints. For facilities designated as critical, hazardous, or essential, in accordance with guidance of TM 5-809-10, delete or make exceptions for piping and ducts which will require seismic restraint.

Seismic restraints may be omitted from the following installations:

a. Gas piping less than [25 mm (1 inch)] [1 inch] inside diameter.

b. Piping in boiler and mechanical equipment rooms less than [32 mm (1-1/4 inches)] [1-1/4 inches] inside diameter.

c. All other piping less than [38 mm (1-1/2 inches)] [1-1/2 inches]

inside diameter.

d. Electrical conduit less than [64 mm (2-1/2 inches)] [2-1/2 inches] inside diameter.

e. Rectangular air handling ducts less than [0.37 square meters (4 square feet)] [4 square feet] in cross sectional area.

f. Round air handling ducts less than [457 mm (18 inches)] [18 inches] in diameter.

g. Piping suspended by individual hangers [300 mm] [12 inches] or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.

h. Ducts suspended by hangers [300 mm] [12 inches] or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

In exemptions g. and h. all hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall be braced.

1.2.7 All Other Interior Piping, Conduit, and Ducts

Interior piping, conduit, and ducts not covered by paragraphs Exclusion or Pipes and Ducts Requiring No special Seismic Restraints shall be seismically protected in accordance with the provisions herein.

1.3 SUBMITTALS

****

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Place a "G" within submittal tags following a submittal item if Government approval for that item is required. Government approval should be required only for items deemed sufficiently critical, complex, or aesthetically significant to merit such action.

For submittals requiring Government approval, a code of up to three characters within submittal tags may be used following the "G" designation to indicate the approving authority.

Submittal items not designated with a "G" are considered as being for information only.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bracing and Coupling; [_____]

Flexible Couplings or Joints; [_____]

Resilient Vibration Isolation Devices; [_____]

Bridge Cranes and Monorails; [_____]

Lighting Fixtures in Buildings; [_____]

Miscellaneous Equipment; [_____]

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-03 Product Data

Bridge Cranes and Monorails; G

Bracing and Coupling; G

Lighting Fixtures in Buildings; G

Miscellaneous Equipment; G

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

SD-07 Certificates

Flexible Ball Joints; [_____]

Flexible ball joints shall be certified to be suitable for the service intended by the manufacturer, based on not less than 2 years' satisfactory operation in a similar application.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the requirements specified below:

2.1.1 Bolts and Nuts

Squarehead and hexhead bolts, and heavy hexagon nuts, ASME B18.2.1, ASME B18.2.2, or ASTM A 307 for bolts and ASTM A 563 for nuts. Bolts and nuts used underground and/or exposed to weather shall be galvanized in accordance with ASTM A 153.

2.1.2 Sway Bracing

****
NOTE: Designer should determine an appropriate specification for steel angles used for sway bracing depending on availability of the materials from local suppliers and insert the designation in blank space below.
****

Material used for members listed [in this section] [and] [on the drawings], shall be structural steel conforming with the following:

a. Plates, rods, and rolled shapes, ASTM A 36.

b. Wire rope, ASTM A 603.

c. Tubes, ASTM A 500, Grade [B] [_____].

d. Pipes, ASTM A 53, Type [E] or [S], Grade B.

e. Light gauge angles, less than [6 mm] [1/4 inch] thickness, [ASTM A 653] [_____].

2.1.3 Flexible Couplings

****
NOTE: Designer should include reference to other specification section containing provisions for pipe pressure and temperature ratings.
****

Flexible couplings shall have same pressure and temperature ratings as adjoining pipe specified in section [_____].

2.1.3.1 Flexible Ball Joints

Flexible ball joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation plus not less than 15-degree angular movement.

2.1.3.2 Flexible Mechanical Joints

a. Mechanical couplings for steel or cast iron pipe shall be of the

sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

b. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets. Underground bolts shall be high-strength type as specified above.

2.1.4 Lighting Fixture Supports

Fixture supports shall be malleable iron. Lighting fixtures and supports shall conform to UL 1570 or UL 1571 as applicable.

PART 3 EXECUTION

3.1 BRACING AND COUPLING

****

NOTE: Designs must include complete seismic details showing bracing and coupling requirements. Designer will be guided by requirements of TM 5-809-10 in establishing bracing and coupling details for Contractor designed systems and for reviewing Contractor's drawings.

Bracing and coupling does not guarantee that the equipment itself is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, the manufacturer should submit information verifying the capabilities of the equipment to withstand seismic loading.

****

Bracing and coupling shall conform to the arrangements shown. Provisions of this paragraph apply to all piping within a [1.5 m] [5 foot] line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group. No trapeze-type hanger shall be secured with less than two [13 mm (1/2 inch)] [1/2 inch] bolts. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.

3.2 BUILDING DRIFT

****

NOTE: The designer will be guided by the requirements of TM 5-809-10 to determine the expected drift of the building. Insert the expected drift ratio (in terms of deflection per unit of

height) in the blank space.
****

Sway braces for a run shall not be attached to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided. Joints capable of accommodating seismic displacements shall be provided where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. For threaded piping, swing joints shall be provided. For piping with manufactured ball joints the seismic drift shall be [0.015] [_____] [meters per meter] [feet per foot] of height above the base where the seismic separation occurs; this drift value shall be used in place of the expansion given in the manufacturer's selection table.

3.3 FLEXIBLE COUPLINGS OR JOINTS

****
NOTE: Designer will be guided by requirements of TM 5-809-10 in establishing bracing and coupling details.
****

3.3.1 Building Piping

Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers larger than [90 mm (3-1/2 inches)] [3-1/2 inches] in diameter. Flexible couplings or joints shall be braced laterally without interfering with the action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets or no-hub fittings may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to comply with these requirements.

3.3.2 Underground Piping

****
NOTE: Include this paragraph if the facility is located within Seismic Zones 2, 3, and 4. The designer will coordinate the requirements for seismic isolation of piping and conduits with the structural and civil design drawings to locate flexible connections as required.

The amount of annular space will depend on the stiffness of the foundation assembly and of the surrounding soil, and the distance between the foundation wall and the point outside the building where the pipe is considered to be restrained. The geotechnical engineer will determine the pipe length to provide fixity. As an approximation, a value of 76 mm (3 inches) would be necessary for a pipe penetration in a one-story basement in soft soil.

****

Underground piping and [100 mm (4 inch)] [4 inch] or larger conduit, except heat distribution system, shall have flexible couplings installed where the piping enters the building. The couplings shall accommodate [_____] [mm] [inches] of relative movement between the pipe and the building in any direction. Additional flexible couplings shall be provided where shown on the drawings.

3.4 PIPE SLEEVES

****

NOTE: The designer will determine the amount of differential movement of piping at pipe sleeves passing through non-fire rated walls and partitions and will indicate on the drawings the amount of clearance required between the pipe and the sleeve based on deflection of the pipe between sway braces on either side of the wall.

The designer should avoid pipe penetrations through fire rated assemblies. Where pipes must penetrate fire rated walls, the space around the pipe should be filled with an approved fire rated material that allows the necessary pipe movement.

****

Pipe sleeves in interior non-fire rated walls shall be sized as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve.

3.5 SPREADERS

Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than [[100] [_____] mm] [[4] [_____] inches] apart. Spreaders shall be applied at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Spreaders shall be applied to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section C-15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.6 ANCHOR BOLTS

3.6.1 Cast-In-Place

****

NOTE: The designer will ensure that foundations and anchor bolts for pad-mounted or floor-mounted equipment are detailed and designed in accordance with TM 5-809-10. When the designer has the necessary size, weight, and other information for a

piece of equipment, the anchorage details including sizes, length and number of bolts, thickness and reinforcing of pads and foundations for that piece of equipment will be shown by the designer on the drawings. When this information is not available, it will be the Contractor's responsibility to design the support and anchorage for the equipment in accordance with the specified requirements.

Two nuts on each bolt will be provided in Seismic Zones 3 and 4. The values shown in paragraph Minimum Bolt Sizes, Cast-In-Place Anchor Bolts may be used to indicate the minimum size and number of bolts required for equipment; the forces in the tabulation are based on the lateral force requirements for rigid and rigidly mounted equipment in TM 5-809-10. The values are based on an Importance Factor (I) of 1.0, which is for facilities other than essential or hazardous facilities. For essential or hazardous facilities the values for bolt size will be computed in accordance with TM 5-809-10 using the appropriate Importance Factor selected from TM 5-809-10, and will be inserted into the tabulation in lieu of the listed values.

The anchor bolt sizes in the tabulation are based on shear strength of the embedded anchor bolt. Overturning forces that may cause tension forces on the bolts have not been included. If the calculated seismic forces would cause the equipment to uplift, the anchor bolts should be designed for combined shear and tension.

****

Floor or pad mounted equipment shall use cast-in-place anchor bolts, except as specified below. [One nut] [Two nuts] shall be provided on each bolt. Anchor bolts shall conform to the following tabulation for the various equipment weights and specified seismic zone or the manufacturer's installation recommendations, whichever is the most stringent, unless otherwise shown on the drawings. Anchor bolts that exceed the normal depth of equipment foundation piers or pads shall either extend into concrete floor or the foundation shall be increased in depth to accommodate bolt lengths.

3.6.2 Minimum Bolt Sizes, Cast-In-Place Anchor Bolts

****

NOTE: Retain applicable zone values only.

****

[Max. Equip. Weight Kg | Minimum Bolt Sizes (mm)* Zone 4 | Zone 3 | Zone 2A | Zone 2B | Zone 1

225	13	13	13	13	13
450	13	13	13	13	13
2250	13	13	13	13	13
4500	13	13	13	13	13
9000	13	13	13	13	13
13500	16	13	13	13	13
22500	22	16	13	13	13
45000	**	**	16	22	13]

[Maximum Equipment Weight (Pounds)	Minimum Bolt Sizes (Inches)* Zone 4	Zone 3	Zone 2A	Zone 2B	Zone 1
500	1/2	1/2	1/2	1/2	1/2
1,000	1/2	1/2	1/2	1/2	1/2
5,000	1/2	1/2	1/2	1/2	1/2
10,000	1/2	1/2	1/2	1/2	1/2
20,000	1/2	1/2	1/2	1/2	1/2
30,000	5/8	1/2	1/2	1/2	1/2
50,000	7/8	5/8	1/2	1/2	1/2
100,000	**	**	5/8	7/8	1/2]

*Based on four bolts per item, a minimum embedment of 12 bolt diameters, a minimum bolt spacing of 16 bolt diameters and a minimum edge distance of 12 bolt diameters. Equivalent total cross-sectional area shall be used when more than four bolts per item are provided. Anchor bolts shall conform to ASTM A 307. Anchor bolts shall have an embedded straight length equal to at least 12 times nominal diameter of the bolt.

**Equipment weighing more than [22,500 kg] [50,000 lb] in Zones 3 and 4 shall have at least six bolts per item.

3.6.3 Expansion or Chemically Bonded Anchors

****

NOTE: Cast-in-place anchors should be used to anchor equipment for seismic loads since there is considerable experience suggesting that expansion and chemically bonded anchors do not perform well for vibrating equipment or for other types of cyclic loading, such as earthquakes.

Expansion and chemically bonded anchors should only be allowed when test data show they are applicable for seismic loading. ASTM E 488 provides a means of testing expansion anchors for seismic loading. In lieu of tests the designer may specify approval of the expansion anchors by a governmental organization such as the City of Los Angeles or the State of California office of Statewide Health Planning and Development (OSHPD).

The edge distance and spacing between anchor bolts greatly affect the shear and tension capacity of the bolts. The spacing will depend on the type of anchor, the diameter, and the length of embedment. The manufacturer should provide data for the minimum edge distance and bolt spacing needed to achieve the rated values and also ways to reduce the allowables if the edge distance or spacing is less than required.

****

Expansion or chemically bonded anchors shall not be used unless test data in accordance with ASTM E 488 has been provided to verify the adequacy of the specific anchor and application. The expansion anchor size shall be not less than that required in paragraph Minimum Bolt Sizes, Cast-In-Place Anchor Bolts. Expansion and chemically bonded anchors shall be installed in accordance with the manufacturer's recommendations. The allowable forces shall be adjusted for the spacing between anchor bolts and the distance between the anchor bolt and the nearest edge, as specified by the manufacturer.

3.6.3.1 General Testing

****

NOTE: Expansion and chemically bonded anchors should be tested after installation. Testing every expansion anchor is not necessary or practical; therefore a reasonable rate of testing should be developed depending on the importance of the job. There are two methods of testing: Torque wrench and pullout testing. The torque test is easier and cheaper and usually gives a good indication of installation quality; the pullout test gives a better indication of the strength of both expansion and chemically bonded anchors. The torque test does not apply to expansion bolts which are anchored by hammering the sleeve over a cone such as self drilling anchors.

****

Expansion and chemically bonded anchors shall be tested in place after installation. The tests shall occur not more than 24 hours after installation of the anchor and shall be conducted by an independent testing agency; testing shall be performed on random anchor bolts as described below.

3.6.3.2 Torque Wrench Testing

****

NOTE: Delete this paragraph for expansion anchors which are not anchored by an applied torque, such as self drilling anchors.

Torque wrench testing verifies that a torqued expansion anchor has seated properly. If it has not seated, the applied torque on the nut will cause the bolt to twist in the hole. Torque wrench testing does not load the bolt up to allowable load and therefore does not verify the capacity of the installed bolt.

****

Torque wrench testing shall be done on not less than [50] [_____] percent of the total installed expansion anchors and at least [one anchor] [[_____] anchors] for every piece of equipment containing more than [two] [_____] anchors. The test torque shall equal the minimum required installation torque as required by the bolt manufacturer. Torque wrenches shall be calibrated at the beginning of each day the torque tests are performed. Torque wrenches shall be recalibrated for each bolt diameter whenever tests are run on bolts of various diameters. The applied torque shall be between 20 and 100 percent of wrench capacity. The test torque shall be reached within one half turn of the nut, except for [9 mm] [3/8 inch] sleeve anchors which shall reach their torque by one quarter turn of the nut. If any anchor fails the test, similar anchors not previously tested shall be tested until [20] [_____] consecutive anchors pass. Failed anchors shall be retightened and retested to the specified torque; if the anchor still fails the test it shall be replaced.

3.6.3.3 Pullout Testing

****

NOTE: Pullout testing is expensive and labor intensive because of the apparatus needed to pull on the anchor bolt. Pullout testing determines the tension capacity of the anchor bolt. The amount of load to be applied can vary between 0.5 to 2 times the design allowable load, depending on the importance of the bolt. There is not a significant cost difference between testing to 0.5 or 2 times the allowable; since most anchor bolts have a factor of safety between allowable and ultimate of 4, testing to twice the allowable should not cause any distress. The typical tension failure causes a shear cone to be pulled out of the concrete, the slope of the cone is about a 45 degree angle so there should be nothing on the concrete surface in the vicinity of the bolt to prevent the cone from pulling out. Shear testing is usually not needed unless the bolt is heavily loaded in shear and close to an edge.

****

Expansion and chemically bonded anchors shall be tested by applying a pullout load using a hydraulic ram attached to the anchor bolt. At least [5] [_____] percent of the anchors, but not less than [three] [_____] per day shall be tested. The load shall be applied to the anchor without removing the nut; when that is not possible, the nut shall be removed and a

threaded coupler shall be installed of the same tightness as the original nut. The test setup shall be checked to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus shall be at least 1.5 times the embedment length away from the bolt being tested. Each tested anchor shall be loaded to [1] [_____] times the design tension value for the anchor. The anchor shall have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested shall be tested until [20] [_____] consecutive anchors pass. Failed anchors shall be retightened and retested to the specified load; if the anchor still fails the test it shall be replaced.

3.7 RESILIENT VIBRATION ISOLATION DEVICES

Selection of anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations shall follow the same procedure as in paragraph ANCHOR BOLTS except that an equipment weight equal to five times the actual equipment weight shall be used.

3.7.1 Resilient and Spring-Type Vibration Devices

****
NOTE: Include this paragraph if the facility is located within Seismic Zone 1 or 2.
****

Vibration isolation devices shall be selected so that the maximum movement of equipment from the static deflection point shall be [15 mm.] [0.5 inches.]

3.7.2 Multidirectional Seismic Snubbers

****
NOTE: Include this paragraph if the facility is located within Seismic Zone 3 or 4. Details of multidirectional seismic snubbers will be shown in drawings if paragraph is retained.
****

Multidirectional seismic snubbers employing elastomeric pads shall be installed on all floor- or slab-mounted equipment. These snubbers shall provide [6 mm] [0.25 inches] free vertical and horizontal movement from the static deflection point. Snubber medium shall consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

3.8 SWAY BRACES FOR PIPING

Sway braces shall be provided to prevent movement of the pipes under seismic loading. Braces shall be provided in both the longitudinal and transverse directions, relative to the axis of the pipe. The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.

3.8.1 Transverse Sway Bracing

****

NOTE: Piping can be either rigid or flexible. Rigid piping has a period of vibration of 0.06 seconds or less. TM 5-809-10 lists the maximum spacing of braces for various types of rigid piping. Piping systems with bracing spacing exceeding the requirements for rigid piping must be considered as flexible.

The bracing requirements shown in paragraph Maximum Span for Transverse Sway Braces in Seismic Zone 4 are based on flexible piping. Supports for flexible piping must consider an additional amplification of the piping being in resonance with the building.

The designer should provide requirements for bracing PVC pipes.

****

Transverse sway bracing for steel and copper pipe shall be provided at intervals not to exceed those given in the tabulation below as modified for each seismic zone. All runs shall have a minimum of two transverse braces. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section C-15400 PLUMBING, GENERAL PURPOSE.

3.8.2 Maximum Span for Transverse Sway Braces in Seismic Zone 4

[

Pipe Diameter	Std. Wgt. Steel Pipe - 40S		Ex. Strong Steel Pipe - 80S		Copper Tube Type L	
(mm)	*L(m)	** F(kN)	*L(m)	**F(kN)	*L(m)	**F(kN)
25	6.7	0.30	6.7	0.4	3.4	0.08
40	7.6	0.60	7.9	0.8	3.7	0.16
50	8.8	1.0	9.1	1.3	4.3	0.30
65	9.8	1.7	10.0	2.1	4.8	0.50
80	10.4	2.5	10.7	3.2	5.2	0.70
90	11.0	3.3	11.6	4.1	5.5	1.0
100	11.9	4.3	12.2	5.3	5.8	1.3
125	12.5	6.4	13.4	8.5	6.1	2.1
150	13.7	9.4	14.0	12.2	6.7	3.3
200	14.9	16.6	16.5	22.9	7.9	6.9
250	16.5	27.1	18.0	34.1	8.5	11.7
300	17.7	38.1	18.6	46.0	9.4	17.6]

[

Pipe Diameter	Std. Wgt. Steel Pipe - 40S		Ex. Strong Steel Pipe - 80S		Copper Tube Type L	
(in.)	*L(ft.)	**F(lbs.)	*L(ft.)	**F(lbs.)	*L(ft.)	**F(lbs.)

1	22	70	22	80	11	17
1-1/2	25	140	26	180	12	35
2	29	220	30	290	14	70
2-1/2	32	380	33	460	15	110
3	34	550	35	710	17	150
3-1/2	36	730	38	930	18	220
4	39	960	40	1,200	19	300
5	41	1,440	44	1,900	20	470
6	45	2,120	46	2,750	22	730
8	49	3,740	54	5,150	26	1,550
10	54	6,080	59	7,670	28	2,630
12	58	8,560	61	10,350	31	3,950]

*L = Maximum span between lateral supports multiplied by 1.1 for Zone 3, 1.25 for Zone 2A, 1.2 for Zone 2B, or 1.35 for Zone 1.

**F = Horizontal force on the brace multiplied by 0.8 for Zone 3, 0.5 for Zone 2A, 0.6 for Zone 2B, or 0.3 for Zone 1.

****

NOTE: Bracing shall consist of at least one vertical angle [50 x 50 mm x 16 gauge] [2 x 2 x 16 gauge] and one diagonal angle of the same size.

****

3.8.3 Longitudinal Sway Bracing

****

NOTE: Systems subject to thermal expansion will show the location of longitudinal sway braces on the drawings because indiscriminate placement of sway braces may interfere with expansion requirements.

****

Longitudinal sway bracing shall be provided at [12 m] [40 foot] intervals except when the location of sway braces is shown on the drawings for the particular piping system. All runs shall have one longitudinal brace minimum. Sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

3.8.4 Vertical Runs

Vertical runs of piping shall be braced at not more than [3 m] [10 foot] vertical intervals. For tubing, bracing shall be provided at no more than [1.2 m] [4 foot] spacing. Vertical braces shall be above the center of gravity of the span being braced. All sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

3.8.5 Anchor Rods, Angles, and Bars

Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in the tabulation below.

3.8.6 Maximum Length for Anchor Braces

[

Type	Size (millimeters)	Maximum length* (meters)	Allowable Loads* (kilonewtons)
Angles	38 x 38 x 6	1.5	25.5
	50 x 50 x 6	2.0	34.5
	64 x 38 x 6	2.5	43.5
	75 x 64 x 6	2.5	48.0
	75 x 75 x 6	3.0	53.0
Rods	91	1.0	16.5
	22	1.0	22.0
Flat Bars	38 x 6	0.4	14.0
	50 x 6	0.4	18.0
	50 x 10	0.5	28.5
Pipes (40s)	25	2.0	18.0
	32	2.8	24.5
	40	3.2	29.5
	50	4.0	39.5]

[

Type	Size (Inches)	Maximum length* (Feet/Inches)	Allowable Loads* (kips)
Angles	1-1/2 x 1-1/2 x 1/4	4-10	5.7
	2 x 2 x 1/4	6-6	7.8
	2-1/2 x 1-1/2 x 1/4	8-0	9.8
	3 x 2-1/2 x 1/4	8-10	10.8
	3 x 3 x 1/4	9-10	11.9
Rods	3/4	3-1	3.7
	7/8	3-8	5.0
Flat Bars	1-1/2 x 1/4	1-2	3.1
	2 x 1/4	1-2	4.1
	2 x 3/8	1-9	6.2
Pipes (40S)	1	7-0	4.1
	1-1/4	9-0	5.5
	1-1/2	10-4	6.6
	2	13-1	8.9]

*Based on the slenderness ratio of l/r = 200 and ASTM A 36 steel, where l is the length of the brace and r is the least radius of gyration of the brace.

3.8.7 Clamps and Hangers

Clamps or hangers on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps or hangers applied over insulation in accordance with Section C-15250 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.8.8 Bolts

Bolts used for attachment of anchors to pipe and structure shall be not less than [13 mm (1/2 inch)] [1/2 inch] diameter.

3.9 SWAY BRACES FOR DUCTS

3.9.1 Braced Ducts

****

NOTE: Select the appropriate SMACNA Seismic Hazard Level (SHL) according to the design seismic zone and insert in the blank space:

Zone	SHL
1	C
2A	C
2B	B
3	B
4	A

For facilities located in seismic zone 4, also select a SMACNA connection level and insert in the blank space. Connection levels are not required in other seismic zones and this paragraph should be edited accordingly.

****

Bracing details and spacing for rectangular and round ducts shall be in accordance with SMACNA-12, including Appendix E, using Seismic Hazard Level [_____] and connection level [_____].

3.9.2 Unbraced Ducts

Hangers for unbraced ducts shall be positively attached to the duct within [50 mm] [2 inches] of the top of the duct with a minimum of two #10 sheet metal screws. Unbraced ducts shall be installed with a [150 mm] [6 inch] minimum clearance to vertical ceiling hanger wires.

3.10 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe.

3.11 EMERGENCY GAS SUPPLY CONNECTIONS

****

NOTE: Include the last sentence if the facility is either essential or hazardous and is located within Seismic Zone 3 or 4. The designer will determine the classification of the facility per TM 5-809-10 and provide a detail on the drawings showing this requirement.

Automatic gas shut-off valves are specified to be activated by the shaking of an earthquake. ANSI has developed standard Z21.70 for automatic shut-off valves which includes a test procedure to verify that the valve will activate during strong ground shaking but will not activate for minor ground shaking or accidental bumping by a pedestrian or vehicle.

The State of California, Division of the State Architect maintains a list of devices that have been tested and conform to the ANSI Standard.

****

Facilities which are to be connected to natural gas distribution systems shall be provided with an aboveground locked, valved and capped emergency gas supply connection. Provisions shall be made for attachment of a portable, commercial-sized gas cylinder system to this connection. Connection shall be located within [300 mm] [12 inches] of the exterior wall and clearly marked with an appropriate metal sign mounted on wall above. An automatic device to safely interrupt the flow of gas to the building in case of an earthquake shall be installed in accordance with ANSI Z21.70, in addition to manual shut-off valves as required by section 02685 GAS DISTRIBUTION SYSTEM.

3.12 EQUIPMENT SWAY BRACING

3.12.1 Suspended Equipment

****

NOTE: Designer will be guided by requirements of TM 5-809-10 in establishing bracing details.

Select the appropriate lateral force coefficient (as a portion of gravity) according to the Seismic Zone in which the facility is located:

Zone	Lateral Force Coefficient (g)
1	**0.28**
2A	**0.56**
2B	**0.75**

3	**1.13**
4	**1.50**

The values listed above assume the equipment is nonrigid or flexibly mounted above grade in the building. The bracketed values in this paragraph are based on an Importance Factor (I) of 1.0 which is for facilities other than essential or hazardous facilities. For essential or hazardous facilities, the values for lateral force or horizontal equivalent static force will be computed in accordance with TM 5-809-10 using the appropriate Importance Factor selected from TM 5-809-10, and will be inserted in this paragraph in lieu of the bracketed values.

Equipment weighing more than one-fifth of the dead load of off-grade slabs at the equipment level or equipment weighing more than one-tenth of the building weight must be checked by structural analysis to conform with building seismic provisions. Such equipment has a pronounced effect on the response of the building. The following items shall be checked structurally in accordance with TM 5-809-10 and specific seismic requirements incorporated on appropriate drawings and in the relevant specifications.

Equipment supported by large pole or frame.

Storage tanks for water and oil.

Storage racks with upper storage level more than 2.4 m (8 feet) in height.

Smoke stacks taller than 15 m (50 feet) in height.

****

Equipment sway bracing shall be provided for items supported from overhead floor or roof structures. Braces shall consist of angles, rods, wire rope, bars, or pipes arranged as shown and secured at both ends with not less than [13 mm (1/2 inch)] [1/2 inch] bolts. Braces shall conform to paragraph Maximum Length for Anchor Braces. Sufficient braces shall be provided for equipment to resist a horizontal force equal to [0.28] [0.56] [0.75] [1.13] [1.50] times the weight of equipment without exceeding safe working stress of bracing components. Details of equipment bracing shall be submitted for approval. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

3.12.2 Floor or Pad Mounted Equipment

3.12.2.1 Shear Resistance

Floor mounted equipment shall be bolted to the floor. Requirements for the number and installation of bolts to resist shear forces shall be in accordance with paragraph ANCHOR BOLTS.

3.12.2.2 Overturning Resistance

****

NOTE: Select the appropriate h/d ratio for equipment according to the Seismic Zone in which the facility is located:

Zone	h/d Ratio
1	**8.89**
2A	**4.44**
2B	**3.33**
3	**2.22**
4	**1.67**

The bracketed values in this paragraph are based on an Importance Factor (I) of 1.0 which is for facilities other than essential or hazardous facilities. For essential or hazardous facilities, the values for h/d ratio will be computed in accordance with TM 5-809-10 using the appropriate Importance Factor selected from TM 5-809-10, and will be inserted in this paragraph in lieu of the bracketed values.

****

The ratio of the height of the equipment (measured from the base to the center of gravity of the equipment) to the minimum distance between anchor bolts shall be used to determine if overturning forces need to be considered in the sizing of anchor bolts. If this ratio is greater than [8.89] [4.44] [3.33] [2.22] [1.67] the bolt values in paragraph Minimum Bolt Sizes, Cast-In-Place Anchor Bolts shall not be used and calculations shall be provided to verify the adequacy of the anchor bolts for combined shear and overturning.

3.13 MISCELLANEOUS EQUIPMENT

3.13.1 Rigidly Mounted Equipment

****

NOTE: The bracketed values in this paragraph are based on an Importance Factor (I) of 1.0 which is for facilities other than essential or hazardous facilities. For essential or hazardous facilities, the values for lateral force or horizontal

equivalent static force will be computed in accordance with TM 5-809-10 using the appropriate Importance Factor selected from TM 5-809-10, and will be inserted in this paragraph in lieu of the bracketed values.

Rigidly mounted equipment is defined as having a period of vibration of 0.06 seconds or less. Equipment with a fundamental period greater than 0.06 seconds should be assumed to be flexibly monunted or nonrigid. For ground-mounted equipment use 2/3 of the values listed below.

List items that may require additional reinforcements (internally) to meet the specified requirements such as boilers, chillers, cooling towers, engine-driven generators, etc., which consist of a number of individual components built into an assembly by the manufacturers. For emergency generators include auxiliary items required for the generator to operate, such as battery racks and day tanks. Select the appropriate lateral force coefficient (as a portion of gravity) according to the Seismic Zone in which the facility is located:

Zone	Lateral Force Coefficient (g)
1	0.06
2A	0.11
2B	0.15
3	0.23
4	0.30

****

The following specific items of equipment to be furnished under this contract shall be constructed and assembled to withstand a horizontal lateral force of [0.06] [0.11] [0.15] [0.23] [0.30] times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake.

Rigidly Mounted Equipment

Boilers
Chillers
Air-Handling Units
Cooling Towers
Engine-Generators
Substations
Transformers

Switch Boards and Switch Gears
Motor Control Centers
Free Standing Electric Motors
Surge Tanks

3.13.2 Nonrigid or Flexibly-Mounted Equipment

****
NOTE: The appropriate lateral force coefficient, based on the guidelines in TM 5-809-10 for nonrigid or flexibly-mounted equipment, should be calculated and inserted in the blank space.
****

The following specific items of equipment to be furnished shall be constructed and assembled to resist a horizontal lateral force of [_____] times the operating weight of the equipment at the vertical center of gravity of the equipment.

3.14 LIGHTING FIXTURES IN BUILDINGS

****
NOTE: Include the following paragraph for seismic zones 2, 3, and 4.
****

Lighting fixtures and supports shall conform to the following:

3.14.1 Pendant Fixtures

****
NOTE: Pendant fixtures should not be used in essential or hazardous facilities.
****

Loop and hook or swivel hanger assemblies for pendant fixtures shall be fitted with a restraining device to hold the stem in the support position during earthquake motions. Pendant-supported fluorescent fixtures shall also be provided with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.

3.14.2 Recessed Fluorescent Fixtures

****
NOTE: Retain last sentence for essential and hazardous facilities only.
****

Recessed fluorescent individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system and shall be fastened thereto at each corner of the fixture with bolts or approved clips; or shall be provided with fixture support wires attached to the

building structural members using two wires for individual fixtures, attached to opposite corners, and one wire per unit of continuous row mounted fixtures. Each wire support shall be capable of supporting four times the weight of the fixture. Recessed lighting fixtures not over [25 kg] [56 pounds] in weight and suspended or pendant-hung fixtures not over [10 kg] [20 pounds] in weight may be supported by and attached directly to the ceiling system runners by a positive attachment such as screws or bolts, number and size as required by design seismic zone. Fixture accessories, including louvers, diffusers, and lenses shall have lock or screw attachments.

3.14.3 Assembly Mounted on Outlet Box

A supporting assembly that is intended to be mounted on an outlet box shall be designed to accommodate mounting features on [100 mm] [4 inch] boxes, [75 mm] [3 inch] plaster rings, and fixture studs.

3.14.4 Surface-Mounted Fluorescent Fixtures

Surface-mounted fluorescent individual or continuous-row fixtures shall be attached to a seismic-resistant ceiling support system. Fixture support devices for attaching to suspended ceilings shall be a locking-type scissor clamp or a full loop band that will securely attach to the ceiling support. Fixtures attached to underside of a structural slab shall be properly anchored to the slab at each corner of the fixture.

3.14.5 Wall-Mounted Emergency Light Unit

Each wall-mounted emergency light unit shall be secured to remain in place during a seismic disturbance.

3.14.6 Lateral Force

****

NOTE: The bracketed values in this paragraph are based on an Importance Factor (I) of 1.0 which is for facilities other than essential or hazardous facilities. For essential or hazardous facilities, the values for lateral force or horizontal equivalent static force will be computed in accordance with TM 5-809-10 using the appropriate Importance Factor selected from TM 5-809-10, and will be inserted in this paragraph in lieu of the bracketed values.

Select the appropriate lateral force coefficient (as a portion of gravity) for the fixture weight according to the Seismic Zone in which the facility is located:

Zone	Lateral Force Coefficient (g)
1	0.28

2A	**0.56**
2B	**0.75**
3	**1.13**
4	**1.50**

****

Light fixture bracing shall be designed to resist a lateral force of [0.28] [0.56] [0.75] [1.13] [1.50] times the fixture weight.

3.15 SUSPENDED CEILING ASSEMBLIES

The structural members of ceiling support systems, used primarily to support acoustical tile panels or acoustical panel lay-in tiles, with or without lighting fixtures, ceiling-mounted air terminals, and ceiling-mounted services, shall conform to the following:

3.15.1 Design Loads

****

NOTE: Use this paragraph for seismic zones 2, 3, and 4. The bracketed values in this paragraph are based on an Importance Factor (I) of 1.0 which is for facilities other than essential or hazardous facilities. For essential or hazardous facilities, the values for lateral force or horizontal equivalent static force will be computed in accordance with TM 5-809-10 using the appropriate Importance Factor selected from the TM 5-809-10, and will be inserted in this paragraph in lieu of the bracketed values.

Select the appropriate percent of ceiling weight according to the Seismic Zone in which the facility is located:

Zone	Percent
2	**11.3**
3	**23**
4	**30**

****

The main runners and cross-runners and their splices and intersection connections shall be designed for two times the design load or ultimate axial tension or compression (minimum [550 N (120 pounds).] [120 pounds.]) The connections at the splices and intersections shall be of a mechanical interlocking type that cannot easily be disengaged. Ceiling structural systems shall be designed to withstand required vertical load as well as a lateral force of [30] [23] or [11.3] percent of the ceiling weight. The ceiling weight shall include all lighting fixtures and other equipment that are laterally supported by the ceiling and shall be not less than [200 Pa (4.0 psf).] [4.0 psf.] Exception: Ceiling areas of [13 square meters] [144 square feet] or less surrounded by walls that connect directly to the

structure above will be exempt from the lateral-load standards of this specification.

3.15.2 Installation Requirements

Installation requirements shall be in accordance with ASTM E 580 except as follows:

3.15.2.1 Vertical Support

Hanger wires supporting a maximum tributary ceiling area of [1.5 square meters] [16 square feet] shall be a minimum of 10 gauge in diameter. The size of wires supporting a tributary ceiling area greater than [1.5 square meters] [16 square feet] shall be substantiated by design calculations. Hanger attachment devices used in ceiling systems not exceeding [200 Pa] [4 psf] shall be capable of supporting a minimum allowable load of [1.3 kN (300 pounds).] [300 pounds.] Hanger attachment devices used in ceiling systems exceeding [200 Pa] [4 psf] shall be capable of supporting the design load and shall be substantiated by design calculations. If hangers must be splayed more than one horizontal to six vertical, the resulting horizontal force shall be offset by bracing or counter-splaying, and substantiated by design calculations.

3.15.2.2 Lateral Support

In lieu of the design criteria stated above, where ceiling loads do not exceed [200 Pa,] [4 psf,] lateral support for the ceiling system may be provided by four galvanized wires of minimum No. 12 gauge, as indicated in ASTM E 580, paragraph 4.4.6.

3.15.3 Lighting Fixture and Air Diffuser Supports

Lighting fixture and air diffuser supports shall be designed and installed to meet the requirements of equipment supports in the preceding paragraphs of this specification with the following exceptions:

a. Recessed lighting fixtures not over [25 kg] [56 pounds] in weight and suspended and pendent-hung fixtures not over [10 kg] [20 pounds] in weight may be supported and attached directly to the ceiling system runners by a positive attachment such as screws or bolts.

b. Air diffusers that weigh not more than [10 kg] [20 pounds] and that receive no tributary loading from ductwork may be positively attached to and supported by the ceiling runners.

3.16 BRIDGE CRANES AND MONORAILS

****

NOTE: The bracketed values in this paragraph are based on an Importance Factor (I) of 1.0 which is for facilities other than essential or hazardous facilities. For essential or hazardous facilities the values for lateral force or horizontal equivalent static force will be computed in

accordance with TM 5-809-10 using the appropriate Importance Factor selected from TM 5-809-10, and will be inserted in this paragraph in lieu of the bracketed values. The lateral force coefficient is based on a value of Cp=1.5 as prescribed in TM 5-809-10. Select the appropriate lateral force coefficient (as a portion of gravity) according to the Seismic Zone in which the facility is located:

Zone	Lateral Force Coefficient (g)
1	0.11
2A	0.23
2B	0.30
3	0.45
4	0.60

****

Bridges cranes and monorails shall be designed to accommodate the following horizontal lateral force coefficient of [0.11] [0.23] [0.30] [0.45] [0.60] times weight, applied in any direction to the center of gravity of the equipment. The weight of such equipment need not include any live load, and the equivalent static force so computed will be assumed to act nonconcurrently with other prescribed nonseismic horizontal forces when considering the design of the crane and monorails. The crane design shall be suitable for the forces previously specified in addition to the normal horizontal loads prescribed by standards cited in other sections of these specifications.

--END OF SECTION-- -- End of Section --